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DOCUMENT-IDENTIFIER: JP **04000353** A

TITLE: HEAT TREATMENT FOR AL-CU ALUMINUM ALLOY INGOT FOR WORKING AND PRODUCTION OF EXTRUDED MATERIAL USING SAME

PUBN-DATE: January 6, 1992

INVENTOR-INFORMATION:
NAME
OKANIWA, SHIGERU
YATSUKURA, MASAHITO
SAITO, KATSUYOSHI

ASSIGNEE-INFORMATION:

NAME	COUNTRY
NIPPON LIGHT METAL CO LTD	N/A
NIKKEI TECHNO RES CO LTD	N/A

APPL-NO: JP02100246

APPL-DATE: April 18, 1990

INT-CL (IPC): C22F001/057, B21C023/00 , C22C021/12

ABSTRACT:

PURPOSE: To increase the strength of a worked product by subjecting an ingot of an Al-Cu alloy containing specific weight percentages of Cu, Mn, Mg, Si, etc., to holding at and for specific temp. and time, immediately to holding at and for specific temp. and time, and then to cooling at specific velocity.

CONSTITUTION: An Al alloy having a composition consisting of, by weight, 1.5-6% Cu, 0.1-1.5% Mn, 0.2-2% Mg, 0.1-1.5% Si, 0.1-0.5% Fe, 0.1-0.3% (Cr+Zr), 0.001-0.2% Ti or 0.001-0.04% B, and the balance Al is subjected to semicontinuous casting so as to be formed into an ingot. This ingot is heated to 300-430°C at ≤200°C/hr temp.-rise rate and held for 0.5-2hr. The ingot is immediately subjected to temp. rise up to 460-500°C, held for 1-24hr, and cooled down to ≤200°C at ≥200°C/hr cooling rate. By this method, the extinction of fiber structure attendant on the progress of recrystallization after aging treatment for an expanded Al-Cu base Al alloy material can be inhibited.

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TITLE: Heat treating aluminium-copper alloy ingot for working - by semi-continuous casting of aluminium alloy melt contg. copper, magnesium, silicon, iron, chromium, and zirconium and heating

PATENT-ASSIGNEE: NIKKEI GIKEN KK[NIMI] , NIPPON LIGHT METAL CO[NIMI]

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PATENT-FAMILY:

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INT-CL (IPC): B21C023/00, C22C021/12 , C22F001/05 , C22F001/057

ABSTRACTED-PUB-NO: JP 04000353A

BASIC-ABSTRACT:

The Al-Cu system Al-alloy ingot is heat treated by semi-continuous casting an Al-alloy melt comprising (by wt.) 1.5-6.0% Cu, 0.10-1.5% Mn, 0.2-2.0% Mg, 0.1-1.5% Si, 0.1-0.5% Fe, 0.04-0.10% Cr, 0.06-0.20% Zr, but 0.10-0.3% Cr+Zr, 0.001-0.20% Ti and/or 0.0001-0.04% B, and balance Al and incidental impurities, into an ingot, heating it to 300-430 deg.C. with upto 200 deg.C./hr. heat-up rate, holding it at the same temp. range for 0.5-2 hrs., heating it to 450-500 deg.C., holding it at the same temp. range for 1-24 hrs., and cooling it to temps. lower than 200 deg.C. with at least 200 deg.C./hr. cooling rate.

The extruded material is made by preheating the Al-Cu system Al-alloy ingot which has submitted to the heat treatment, to 300-450 deg.C., and extruding it with 1-10 m/min. extrusion rate, but to have the temps. of the extruded material upto 500 deg.C., with at least 10% redn..

USE - Used for making high strength Al-Cu alloy extruded prods., capable of obtaining sufficient strength of the flattened material after soln. treatment.

CHOSEN-DRAWING: Dwg.0/0

⑲日本国特許庁（JP）　⑪特許出願公開

⑫公開特許公報（A）　平4－353

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審査請求　未請求　請求項の数　3　（全8頁）

㊹発明の名称　加工用Ａｌ－Ｃｕ系アルミニウム合金鋳塊の熱処理法およびこれを用いた押出材の製造法

㉑特　願　平2－100246

㉒出　願　平2(1990)4月18日

㉗発明者　岡庭　茂　静岡県庵原郡蒲原町蒲原1丁目34番1号　株式会社日軽技研内

㉗発明者　谷津倉　致仁　静岡県庵原郡蒲原町蒲原1丁目34番1号　株式会社日軽技研内

㉗発明者　斉藤　勝義　静岡県庵原郡蒲原町蒲原161番地　日本軽金属株式会社蒲原製造所内

㉑出願人　日本軽金属株式会社　東京都港区三田3丁目13番12号

㉑出願人　株式会社日軽技研　東京都港区三田3丁目13番12号

明　細　書

１．発明の名称

加工用Ａℓ－Ｃｕ系アルミニウム合金鋳塊の熱処理法およびこれを用いた押出材の製造法

２．特許請求の範囲

（１）重量基準にてＣｕ１．５～６．０％、Ｍｎ０．１０～１．５％、Ｍｇ０．２～２．０％、Ｓｉ０．１～１．５％およびＦｅ０．１～０．５％を含有し、さらにＣｒ＋Ｚｒが０．１０～０．３％の範囲になるようにＣｒ０．０４～０．１０％およびＺｒ０．０６～０．２０％を含有し、さらにＴｉ０．００１～０．２０％またはＢ０．００１～０．０４％の一方または両者を含み、残部Ａℓおよび不可避的不純物からなるアルミニウム合金溶湯を半連続鋳造して鋳塊とし、次にこの鋳塊を２０．０℃／時間以下の昇温速度で３００～４３０℃に加熱昇温後、同温度範囲にて０．５～２時間保持し、保持後直ちに４５０～５００℃の温度範囲に加熱昇温して、同温度範囲にて１～２４時間保持した後、２００℃／時間以上の冷却速度で２００℃以下の温度まで冷却することを特徴とする加工用Ａℓ－Ｃｕ系アルミニウム合金鋳塊の熱処理法。

（２）重量基準にてＣｕ１．５～６．０％、Ｍｎ０．１０～１．５％、Ｍｇ０．２～２．０％、Ｓｉ０．１～１．５％およびＦｅ０．１～０．５％を含有し、さらにＣｒ＋Ｚｒが０．１０～０．３％の範囲になるようにＣｒ０．０４～０．１０％およびＺｒ０．０６～０．２０％を含有し、さらにＴｉ０．００１～０．２０％またはＢ０．００１～０．０４％の一方または両者を含み、残部Ａℓおよび不可避的不純物からなるアルミニウム合金溶湯を半連続鋳造して鋳塊とし、次にこの鋳塊を１００℃／時間以下の昇温速度で４３０～５００℃に加熱昇温後、同温度範囲にて１～２４時間保持した後、２００℃／時間以上の冷却速度で２００℃以下の温度まで冷却することを特徴とする加工用Ａℓ－Ｃｕ系アルミニウム合金鋳塊の熱処理法。

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(3) 請求項1または2記載による熱処理を施した加工用Aℓ−Cu系アルミニウム合金鋳塊を用いて押出比10以上の押出材に押出加工するに際し、該鋳塊を300〜450℃の温度に予熱し、1〜10m／分の押出速度でしかも押出材の温度が500℃以下になるようにして押出加工を施すことを特徴とするAℓ−Cu系アルミニウム合金押出材の製造法。

3. 発明の詳細な説明

［産業上の利用分野］

本発明は、展伸加工後の合金材を溶体化処理した場合においても強加工組織（加工繊維組織）を十分に維持し得るような時効硬化型のAℓ−Cu系アルミニウム合金鋳塊の熱処理法およびこの鋳塊を用いた押出材の製造法に関するものである。

［従来の技術］

Aℓ−Cu系合金の如き時効硬化型のアルミニウム合金は熱処理を施すことによって、加工材に優れた強度を付与することができることから自動車、オートバイ等の強度部品に用いられている。

即ち、Aℓ−Cu系合金鋳塊からこのような強度部品を得るためには、合金鋳塊を500℃付近に数時間の保持を行なう均質化処理を施した後、押出、圧延、鍛造等の展伸加工を施して適宜の形状に成形して、得られた加工製品に更に強度を付与するために溶体化処理、焼入れ、焼戻しによる一連の時効硬化処理が行なわれている。

［発明が解決しようとする課題］

しかしながら、上記した方法によって得られた加工製品は、時効処理を施しても多くの場合において予期する程の十分な強度が得られず強度部品としての使用に制限を受けるのが現状である。

本発明は上記の実情に鑑み、溶体化処理後において、より高い強度を有する加工製品を得ることのできるようなAℓ−Cu系アルミニウム合金鋳塊の製造法およびこれによって得られた鋳塊を使用した強度の高い押出材製品の製造法を提供することを目的とするものである。

［課題を解決するための手段］

発明者らは、上記時効硬化型のアルミニウム合金が時効処理後において、予期した程の強度向上効果が得られない原因について種々研究を行なった結果次のことが判かった。即ち、アルミニウム合金に押出、圧延等の塑性加工を施すと加工による金属の流れの方向に結晶粒が変形して繊維状の組織が得られる。この加工繊維組織は強加工組織とも呼ばれており、合金に高い強度を与えるものである。ところで、Aℓ−Cu系合金においては加工後に時効硬化のための熱処理を施した場合に往々にして、強加工組織が再結晶を起こして部分的に消滅してしまう。 従って、時効効果処理に際しての一連の熱処理を施した後においても、大部分の強加工組織が維持されるような手段を講ずる必要がある。

発明者らは上記の知見に基きAℓ−Cu系合金において、加工後の熱処理による強加工組織の消滅を可及的に避けることができるような方法について検討を重ねた結果、特定組成を有するAℓ−Cu系合金においては、半連続鋳造後の鋳塊に施す均質化処理においてその加熱速度を一定の値以下に制御して所定の熱処理温度に到達させるようにするときは、この均質化処理を施して得られた鋳塊に展伸加工を加えることによって得られた加工材は、其の後に強度付与のための溶体化処理等の熱処理を施しても、上記の強加工組織が部分的に再結晶して消滅するようなことがなくその大部分を維持し得ることを見出し、以下の三つの発明を完成した。

即ち本発明における第1の発明は、重量基準にてCu1.5〜6.0％、Mn0.10〜1.5％、Mg0.2〜2.0％、 Si0.1〜1.5％およびFe0.1〜0.5％を含有し、さらにCr+Zrが0.10〜0.3％の範囲になるようにCr0.04〜0.10％およびZr0.06〜0.20％を含有し、さらにTi0.001〜0.20％またはB0.0001〜0.04％の一方または両者を含み、残部Aℓおよび不可避的不純物からなるアルミニウム合金溶湯を半連続鋳造して鋳塊とし、次にこの鋳塊を200℃／時間以下の昇温速度で300〜430℃に加熱昇

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温した後、同温度範囲にて０．５～２時間保持して、保持後直ちに４５０～５００℃の温度範囲に加熱昇温し、同温度範囲にて１～２４時間保持した後に、２００℃／時間以上の冷却速度で２００℃以下の温度まで冷却することを特徴とする加工用Aℓ－Cu系アルミニウム合金鋳塊の熱処理法であり、また本発明の第２の発明は、重量基準にてCu１．５～６．０％、Mn０．１０～１．５％、Mg０．２～２．０％、 Si０．１～１．５％およびFe０．１～０．５％を含有し、さらにCr＋Zrが０．１０～０．３％の範囲になるようにCr０．０４～０．１０％およびZr０．０６～０．２０％を含有し、さらにTi０．００１～０．２０％またはB０．０００１～０．０４％の一方または両者を含み、残部Aℓおよび不可避的不純物からなるアルミニウム合金溶湯を半連続鋳造して鋳塊とし、次にこの鋳塊を１００℃／時間以下の昇温速度で４３０～５００℃に加熱昇温後、同温度範囲にて１～２４時間保持した後、２００℃／時間以上の冷却速度で２００℃以下の温度まで冷却することを特徴とする加工用Aℓ－Cu系アルミニウム合金鋳塊の熱処理法であり、さらに第３の発明は、上記第１発明または第２発明によって得られた加工用Aℓ－Cu系アルミニウム合金鋳塊を用いて、押出比１０以上の押出材に押出加工するに際し、該鋳塊を３００～４５０℃の温度に予熱し、１～１０m／分の押出速度でしかも押出材の温度が５００℃以下になるようにして押出加工を施すことを特徴とするAℓ－Cu系アルミニウム合金押出材の製造法である。

［作　用］

先ず本発明において使用するAℓ－Cu系アルミニウム合金の含有成分および含有割合について説明する。

Cu：１．５～６．０％

CuはMgと共存してAℓ－Cu系合金の熱処理強度を向上させるものであり、下限値未満では時効処理による強度向上効果が少なく、上限値を超えると熱処理による強度向上の効果は飽和し、逆に塑性加工に際しての微細割れ等の欠陥を生じ易くする。

Mg：０．２～２．０％

MgはCuと共存してAℓ－Cu系合金の熱処理強度を向上させるものであり、下限値未満では時効処理による強度向上効果が少なく、上限値を超えると加工性が低下するようになる。

Fe：０．１～０．５％

Feは鋳造組織を微細化して鋳造割れを防止する効果を有する。下限値未満ではその効果が少なく、上限値を超えるとAℓ－Fe（X）－Si系化合物（X：遷移金属）やAℓ－Cu－Fe系化合物の晶出量が多くなり、塑性加工を行なった場合に、得られた加工材に微細な割れ欠陥を生じ易くなると共に、合金中に添加した他の有効元素の添加効果を減少させる。

Si：０．１～１．５％

SiはMgと共存することによって時効処理に際してMg_2Siを析出し合金の強度を向上させる効果を有する。下限値未満ではその効果が少なく、上限値を超えるとAℓ－Fe（X）－Si系化合物（X：遷移金属）の晶出量が多くなって、展伸加工によって得られる加工材に微細割れ欠陥を生じ易くすると共に、合金中に添加した他の有効元素の添加効果を減少する。

Mn：０．１０～１．５％

Mnは鋳造組織を微細化して鋳造割れを防止すると共に展伸加工を施して得られる加工材における加工組織を微細組織となし、材料強度を向上する効果を有する。下限値未満ではその効果が少なく、上限値を超えると加工性を阻害する。

Cr：０．０４～０．１０％および
Zr：０．０６～０．２０％

CrおよびZrは両者を合金中に共存させることによって、以下に説明する本発明による鋳塊熱処理法を施すことにより、鋳塊中に固溶したCrおよびZrを微細なAℓ－Cr系化合物、Aℓ－Zr系化合物またはAℓ－Cr－Zr系化合物として析出させて、加工によって形成された繊維状の加工組織を爾後の時効処理において再結晶の進行を妨げ、強度を向上させる効果を有する。

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しかしてCrおよびZrの合計量が0．10％未満ではその効果が少なく、また0．3％を超えると加工性を低下させる。従ってCrおよびZr含有量は上記した範囲内に留める必要がある。

Ti：0．001～0．10％および／または
B：0．0001～0．02％

TiおよびBはそれぞれ単独で、または共存して合金の鋳造組織を微細化し、鋳造割れを防ぐ効果を有し、それぞれその下限値未満ではその効果が少なく、また上限値を超えるとAℓ－Ti系化合物、Aℓ－B系化合物、またはAℓ－Ti－B系化合物の巨大化合物を晶出して、加工に際して割れ発生の起点となり、或いは割れの伝播経路となって何れも加工性を低下する。

上記した組成を有するAℓ－Cu系アルミニウム合金鋳塊は、常法によって溶製したそれぞれの合金元素を所定量宛含む合金溶湯を水冷式半連続鋳造法によって鋳造することによって得られる。

鋳造に際して必要に応じ常法による溶湯の脱ガス処理を施したり、多孔質フィルターの使用による介在物の濾過処理を施すことは鋳塊品質の向上を図る上で好ましいことである。

水冷式半連続鋳造法で鋳造した鋳塊は合金元素が十分に固溶されているので、爾後の熱処理によってそれぞれ上記したような添加効果を十分に発揮することができる。

鋳塊のサイズは特に限定されるものでなく、例えば押出用として用いる場合などにおいては、小は20～60mmφ程度の小径ビレットから大は340φmm以上の所謂大型ビレットまで用途に応じて任意に採用することができる。

本発明の第1および第2発明は、すべて上記のようにして製造された半連続鋳造による特定合金組成を有するAℓ－Cu系アルミニウム合金鋳塊を用いてこれを特定の熱処理条件によって均質化処理を施すことによって、展伸加工後の合金材に時効処理を施した場合において、加工材に形成された強加工組織に対する再結晶の進行を抑え、強加工組織を可及的に維持し得るようにしたものである。

即ち第1の発明においては、上記の鋳塊を均質化処理するに際し、鋳塊を200℃／時間以下の昇温速度にて300～430℃の温度範囲に加熱昇温し、該温度範囲にて0．5～2時間保持し、保持後直ちに450～500℃の温度範囲まで加熱昇温して、同温度範囲にて更に1～24時間の保持を行ない、しかる後200℃／時間以上の冷却速度で200℃以下の温度迄冷却するものであって、このような熱処理条件のもとで鋳塊の均質化処理を行なうことによって、加工後の製品に時効処理を施した場合に従来よりも著しく高い強度の展伸材製品が得られる。その理由は十分に明確ではないが、鋳塊を200℃以下の比較的遅い昇温速度で300℃付近の温度までゆっくりと加熱昇温させると、この間において鋳塊中に固溶しているMn、CrおよびZrが微細均質に析出して結晶核を形成する。次いで、鋳塊を300～430℃の温度範囲に一旦保持して残余のMn、CrおよびZrを析出させることによって鋳塊組織中に十分な量の微細均質なMn、Crおよび／またはZrを含有する化合物を形成させる。

このようにして鋳塊中に均一に析出形成せしめたMn、Cr、Zr等の遷移金属の微細化合物の存在によって、鋳塊を展伸加工後に時効処理を施した際に、展伸材に形成されている繊維状強加工組織の再結晶による消滅が妨げられ、強加工組織の大部分が残存するために合金は時効処理に基く時効性合金本来の強度向上効果に加え、更に高い強度を得ることができるものと思われる。

本発明の効果を十分に発揮させるためには鋳塊の昇温速度を200℃以下の比較的低い昇温速度で加熱昇温させることが必須であって、これよりも大きい昇温速度であるときは鋳塊中に析出するCr、Zr等による化合物が粗大となって、均質に析出させることができず、所期の効果が得られない。また、300～430℃での0．5～2時間の低温保持も重要な要件であって、この保持条件が300℃未満の温度、もしくは0．5時間未満の保持時間であるときは鋳塊中に均質で且つ十分な量の微細析出物が形成されず、所期の効果が

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得られない。また430℃を超える温度、もしくは2時間を超える時間の保持を行なっても上記した効果をこれ以上増加させることができず、却って経済的に不利となる。

その後鋳塊を450～500℃に昇温して1～24時間の保持を行なうが、これは鋳造において偏析したCu、Mg、Fe、Si等の元素を再固溶させて、爾後の展伸加工およびこれに続く時効処理によって、時効硬化型合金本来の強度を発揮させるためのものであって、保持条件が450℃未満の温度、もしくは1時間未満であるときはその効果が少なく、また500℃を超える温度、もしくは24時間を超える時間で保持を行なってもこれ以上の効果が得られず経済的でない。

次に高温での保持を終了した鋳塊は直ちに200℃／時間以上の冷却速度で鋳塊温度が200℃以下の温度になるまで冷却する。これは先に450～500℃の温度に保持することによって、固溶させたCuおよびMgの再析出を可及的に防止し、爾後の展伸材の時効処理によってこれらの元素の十分な量を析出させて、強度を向上させるためのものであって、例えば強制空冷等の手段によってこの冷却速度を得ることができる。

また第2の発明においては鋳塊の均質化処理における加熱を第1発明におけるよりも更に低い昇温速度の100℃／時間以下の温度勾配で行ない430～500℃に到達後、同温度に1～24時間保持し、しかる後200℃／時間以上の冷却速度で200℃以下の温度迄冷却するものであり、このような熱処理条件で鋳塊の熱処理を行なうことによって、第1発明と同様に展伸加工を施して得られた展伸材製品の時効処理後の強度を従来に増して高めることができる。その理由としては、鋳塊の昇温速度を第1発明の場合よりも更に遅い100℃／時間以下の昇温速度でゆっくりと430℃～500℃の温度範囲まで加熱すると、この間に鋳塊中のMn、CrおよびZrは更に均質微細に析出して結晶核を形成し、更に430～500℃における保持によって、これらMn、CrおよびZrの十分な量の微細化合物が均質に形成されて、これが第1発明において述べたと同様の理由で鋳塊の展伸加工後の展伸材製品における時効処理後の強度増加に優れた効果を及ぼすものと思われる。

本第2発明においては合金鋳塊を第1発明よりも更に低い昇温速度の100℃／時間以下の昇温速度で加熱するのであるから、昇温の過程において鋳塊中に固溶されているMn、CrおよびZrは、より多く且つ均質微細に析出する。従って、第1発明において行なったような低温での加熱保持を行なわなくても十分な量のMn、CrおよびZrの析出に基く微細化合物を確保し得るのである。言換えれば昇温速度が100℃／時間を超えるときは、鋳塊中において析出するMn、CrおよびZrはより大きい析出物となり、従って結晶核の発生点がより粗になるので第1発明における如く更に低温での保持を行なうことによって、更に多くの析出物の発生を期待しなければならなくなるのである。

430～500℃の温度範囲における保持は一部Mn、CrおよびZrの更なる析出化合物の形成も期待されるが、本質的には鋳塊中に偏析するCu、Mg、FeおよびSi等の元素の再固溶を図り、展伸加工によって得られた加工材製品の時効処理での強度向上を図るためのものであることは第1発明の場合と変りない。従って保持条件が430℃未満の温度、あるいは1時間未満の保持時間ではその効果の少ないこと、また500℃を超える温度、あるいは24時間を超える時間の保持では、経済的に不利になることなどについても第1発明と同様である。

また、加熱保持を終了した鋳塊を200℃／時間以上の温度で200℃以下の温度まで急冷させる理由についても第1発明の項で述べた通りである。上記の第1または第2発明に示した熱処理条件によって、均質化処理を施したAℓ－Cu系合金鋳塊は押出、圧延、鍛造等の展伸加工を施すことによって任意の形状を有する加工製品を得ることができるが、特に押出加工による場合に顕著な効果を示す。

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第３の発明はかかるＡℓ－Ｃｕ合金鋳塊から優れた強度を有する押出材製品を得るための好ましい押出加工法を提供するものであって、該鋳塊を３００～４５０℃の温度範囲に予熱した後、押出比を１０以上とし、１～１０ｍ／分の押出速度でしかも押出材の温度が５００℃を超えないようにして押出を行なうものである。

鋳塊を３００～４５０℃の温度範囲に予熱するのは鋳塊の押出加工性を向上させるために行なわれるものであって、予熱温度３００℃未満ではその効果が少なく、また４５０℃を超えると加工に際しての発生熱によって押出材の温度が上がりすぎて、加工による繊維組織が再結晶により消滅してしまう危険性がある。

押出比を１０以上としたのは押出材に十分に加工繊維組織を発達させるためである。押出速度を１～１０ｍ／分の範囲に限定したのは１０ｍ／分を超えると加工による発生熱により押出材の加工組織が再結晶してやはり高強度が得られず、また１ｍ／分未満では経済性に乏しいからである。

押出材の温度が５００℃を超えないように制御するのは、５００℃を超えると押出材は表面劣化して割れを生じ易くなるからである。また、一般に押出加工においては押出操作が進むにつれて、ダイス内の鋳塊は加工による発生熱によって昇温し、押出初期よりも後期において得られる押出材の温度が上昇し、再結晶を起し易くなる。従って加工中に押出機内での温度が５００℃を超えるような場合にはダイス端部において押出材を強制空冷するなどの冷却手段を講ずる必要がある。

このようにして得られた押出材は、次に時効処理を施して高強度を付与する。時効処理の条件としては一般に行なわれるように、４９５～５１０℃の温度範囲に０．５時間以上保持して溶体化処理を行ない、次いでこれを焼入後１６０～１８０℃の温度範囲に２～８時間保持して焼戻処理を行なう。

第１発明もしくは第２発明による均質化処理を施したＡℓ－Ｃｕ系合金鋳塊を、特に上記の第３発明において開示された押出条件を採用して押出加工を施して得られた押出材は、時効処理を施すことによって従来にない強度の優れた押出製品とすることができる。

［実施例］

次に本発明の実施効果を実証するために発明者が行なった幾つかの実施例について説明する。

第１表に示すような化学組成を有する１５種類（本発明合金：合金番号１～１０、比較合金：合金番号１１～１５：）のＡℓ－Ｃｕ系アルミニウム合金溶湯から水冷式連続鋳造法を使用して３２５ｍｍφの押出用鋳塊を得た。

次にこれらの鋳塊を使用して、第２表に示す如く実施例１においては本発明の組成範囲に該当する合金（合金番号１～１０）および比較合金（合金番号１１～１５）を本発明の第１発明の２段の熱処理条件で均質化処理を施したもの、実施例２では本発明合金（合金番号２、１０）および比較合金（合金番号１１、１４）についてそれぞれ、本発明の第２発明の熱処理条件、即ち低昇温速度条件での１段熱処理による均質化処理を施し、し

第1表

	合金番号	化学組成 (wt%) Cu	Mg	Fe	Si	Mn	Cr	Zr	Ti	B	その他	Al
本発明合金	1	1.8	1.5	0.2	0.1	0.65	0.06	0.08	0.01	-	0.01	残
	2	3.5	1.5	0.2	0.1	0.65	0.05	0.07	0.01	-	0.01	残
	3	3.5	1.0	0.2	0.1	0.65	0.05	0.10	0.02	-	0.01	残
	4	4.5	0.3	0.4	0.1	0.65	0.08	0.06	0.01	-	0.01	残
	5	4.5	1.5	0.1	1.2	0.20	0.06	0.08	0.01	-	0.01	残
	6	5.8	0.5	0.1	0.5	0.80	0.04	0.20	0.01	-	0.01	残
	7	4.5	1.5	0.1	0.1	1.30	0.10	0.18	0.01	-	0.01	残
	8	2.5	1.5	0.1	0.1	0.65	0.06	0.07	0.01	0.001	0.01	残
	9	4.5	1.0	0.2	0.8	0.65	0.06	0.08	0.01	-	0.01	残
	10	4.5	1.5	0.2	0.3	0.65	0.04	0.06	0.01	0.001	0.01	残
比較合金	11	4.5	1.5	0.2	0.2	0.65	-	-	0.01	-	0.01	残
	12	4.5	1.5	0.2	0.2	0.65	0.06	-	0.01	-	0.01	残
	13	4.5	1.5	0.2	0.2	0.65	-	0.06	0.01	-	0.01	残
	14	4.5	1.5	0.2	0.2	0.65	0.12	-	0.01	-	0.01	残
	15	4.5	1.5	0.2	0.2	0.65	-	0.25	0.01	-	0.01	残

注：第1表中その他は表示以外の元素の夫々を示し、その含有量の0.01は夫々0.01以下であることを示す。

第2表

実施例No.	合金番号	均質化処理条件 昇温	保持	保持	冷却
①	1 ～15	100℃/h→	350℃×1h→	460℃×4h→	300℃/h
②	2、10、11、14	50℃/h	→	460℃×4h→	300℃/h
③	2、10、11、14	250℃/h	→	460℃×4h→	100℃/h

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かる後これを強制空冷したもの、実施例3では同上の2種の合金について、従来の一般的な熱処理条件、即ち本発明の第2発明の昇温速度条件よりもかなり高い昇温速度で加熱を行なう1段熱処理での均質化処理を施し、処理後放冷したものについて、各鋳塊を本発明の押出条件、即ち400℃に予熱後、押出速度4m／分で押出材のダイス端における温度が500℃以下になるようにして径50mmφ、長さ50mの丸棒の押出しを行なった。次に得られた丸棒に500℃に2時間保持した後水焼入れを施して溶体化処理を施し、次いで170℃に6時間保持して人工時効処理（T_6処理）を施した。

これらT_6処理を施した押出材の先端から約20mおよび約40mの位置から強度試験試料および組織検査試料を切り出し、強度試験試料については抗張力（σ_B）および耐力（$\sigma_{0.2}$）の測定を行ない、また組織検査試料については、光学顕微鏡による合金組織の観察を行ない、直径方向に対する再結晶厚さを測定し、その比率を算出した。

第3表 (実施例1)

	合金番号	20m σ_B	20m $\sigma_{0.2}$	40m σ_B	40m $\sigma_{0.2}$	20m 再結晶厚%	40m 同 %	評価 強度	評価 組織
本発明合金	1	35	32	35	31	0.05	0.05	○	○
	2	54	50	53	51	0.03	0.05	○	○
	3	53	51	52	50	0.03	0.06	○	○
	4	52	48	51	49	0.06	0.08	○	○
	5	62	58	59	56	0.05	0.10	○	○
	6	50	46	50	46	0.07	0.07	○	○
	7	60	55	59	56	0.05	0.05	○	○
	8	40	35	41	34	0.06	0.06	○	○
	9	58	56	57	54	0.06	0.08	○	○
	10	61	57	59	56	0.07	0.10	○	○
比較合金	11	53	51	48	45	1.0	5.0	×	×
	12	54	52	49	45	1.1	1.5	△	×
	13	52	49	48	45	1.2	2.1	×	×
	14	55	50	49	46	1.0	1.1	△	×
	15	55	50	50	45	1.0	1.2	△	×

注：表中20m、40m はビレット先端部からの試料採取位置を示す。
またσ_B、$\sigma_{0.2}$ の単位は kg/mm² である。

第4表

合金番号	(実施例2) σ_B kg/mm² 20m	(実施例2) σ_B kg/mm² 40m	(実施例2) 再結晶厚% 40m	(実施例3) σ_B kg/mm² 20m	(実施例3) σ_B kg/mm² 40m	(実施例3) 再結晶厚% 40m
2	52	51	0.06	49	47	1.0
10	58	57	0.12	55	50	1.2
11	51	46	7.0	50	44	12.0
14	55	50	1.2	52	48	1.5

注：表中20m、40m はビレット先端部からの試料採取位置を示す。

実施例1の鋳塊による結果を第3表に、また実施例2および3の鋳塊による結果を第4表にそれぞれ示す。

即ち、第3表は本発明合金および比較合金について、本発明の第1発明による熱処理条件によって均質化処理を行なった鋳塊を本発明の第3発明による押出加工を行なった押出材の前後異なる2箇所における時効処理後の強度、再結晶の状態を調べた結果を示すものであるが、第3表の結果からCr、Zrの適量を共存させた本発明による合金組成を有するAℓ－Cu合金鋳塊（合金番号1～10）を第1発明による熱処理条件によって均質化処理を施した鋳塊から得られた押出材は時効処理後における再結晶層の厚みが薄く、押出材の直径方向に占める再結晶層の厚さの割合がすべて0.1％以下であって再結晶がさして進行せず、しかも製品の前後（先端から20mmおよび40mm）何れの部分をとってもその値にさしたる変化がないのに対して、Cr、Zrをそれぞれ単独で添加するか、若しくは全く添加しない本発明の組成を外れる組成の比較合金鋳塊（合金番号11～15）から得られた押出材製品においては再結晶層の厚みが厚く直径に対する比率が1以上であって再結晶が相当程度進んでおり、しかも製品の前部と後部でその値のバラツキが大きいこと、また同表中における本発明合金（合金番号5、7、および10）から得られた製品と比較合金（合金番号11～15）から得られた製品の強度を比較すると、これらの製品は合金中に含有されるCuおよびMg量が同一であるところから、時効処理後の強度がほぼ同一水準にあることが期待されるにも拘らず本発明合金によるものは、比較合金によるものに比べて抗張力、耐力何れを採っても著しくその値が高いことが判かる。また、第3表の結果から本発明の組成範囲内に該当する組成を有する合金を使用したものは、すべて再結晶層が薄く、つまり時効処理後においても強加工組織が顕著に残留し、従って押出材の強度向上に好ましい結果となることが判かる。

第4表左欄（実施例2）は本発明合金（合金番

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号2、10)および比較合金(合金番号11、14)について第2発明による遅い昇温速度で昇温させる熱処理条件で均質化処理を施した鋳塊を、また右欄(実施例3)は同様の合金について、通常の昇温速度即ち第2発明による昇温速度より早い昇温速度で均質化処理を施した鋳塊を、それぞれ本発明の押出条件によって押出加工を行なった押出材について、時効処理後押出材の前後2箇所(先端より5mおよび40m)における強度と後部(先端より40m)における再結晶の進行状況を調べた結果を示したものであるが、第4表左欄実施例2の結果から第2発明による熱処理を施した場合においても、本発明の合金(合金番号2、10)を使用した場合には得られた押出材の時効処理後の再結晶層の厚みは薄く、再結晶があまり進んでいないのに対し、比較合金(合金番号11、14)使用の場合には再結晶層の厚みが厚く再結晶がかなり進行していること、また第4表右欄実施例3の結果から本発明合金を使用した場合においても均質化処理が第2発明の条件を逸脱したものであるときは、押出材における再結晶層の厚みが厚く、つまり再結晶が進行してしまうことなどが判かる。

また、この再結晶の進行状況を示す結果は直ちに押出材の強度に影響を及ぼすものであって、第4表左欄における本発明合金と比較合金のうち、同一Cu、Mg含有量の合金を比較した場合において、合金番号10の本発明合金によるものの強度は合金番号11および14の比較合金によるものの強度に比べて著しく高いことが判かるし、また左右欄に示された強度測定結果から、本発明の同一組成を有する合金を使用した場合でも均質化処理に際しての昇温速度が本第2発明の昇温度速よりも大きく、均質化処理後の冷却速度の遅い従来の通常的な熱処理条件による場合には、押出材における再結晶の厚さが厚くなるとともに、強度が著しく低下することが判かる。

以上の実施例は鋳塊の均質化処理後に行なう展伸加工法として、特に本発明の第3発明による押出加工を採用したものについて述べたが、加工手段はこれに限られるものでなく、勿論これ以外の加工法、例えば圧延加工、鍛造加工等他の加工法を採用する場合においても同様の優れた効果が期待できる。

[発明の効果]

以上述べたように本発明の鋳塊の均質化処理法を採用するときはAℓ－Cu系アルミニウム合金展伸材の時効処理後における再結晶の進行に伴う加工繊維組織の消滅が抑えられるので、時効処理効果と相まって加工材製品の強度を更に一層高めることができるので工業的な利用価値の高い発明であるといえる。

特許出願人　日本軽金属株式会社
株式会社　日軽技研

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CLAIMS

[Claim(s)]
[Claim 1] On weight criteria, 1.5 - 6.0% of Cu(s), 0.10 - 1.5% of Mn, 0.2 - 2.0% of Mg, Contain 0.1 - 1.5% of Si, and 0.1 - 0.5% of Fe(s), and 0.04 - 0.10% of Cr(s) and 0.06 - 0.20% of Zr are contained so that Cr+Zr may become 0.10 - 0.3% of range further. Furthermore, 0.001 - 0.20% of Ti, B0.0001-0.04% one side, or both are included. Carry out semi-continuous casting of the aluminium alloy molten metal which consists of the remainder aluminum and an unescapable impurity, and it considers as an ingot. Next, hold this ingot after a heating temperature up at 300-430 degrees C with the programming rate of 200 degrees C/hour or less in this temperature requirement for 0.5 to 2 hours, and a heating temperature up is immediately carried out to a 450-500-degree C temperature requirement after maintenance. The method of heat-treating the aluminum-Cu system aluminium alloy ingot for processing characterized by cooling to the temperature of 200 degrees C or less with the cooling rate of 200 degrees C/hour or more after holding in this temperature requirement for 1 to 24 hours.
[Claim 2] On weight criteria, 1.5 - 6.0% of Cu(s), 0.10 - 1.5% of Mn, 0.2 - 2.0% of Mg, Contain 0.1 - 1.5% of Si, and 0.1 - 0.5% of Fe(s), and 0.04 - 0.10% of Cr(s) and 0.06 - 0.20% of Zr are contained so that Cr+Zr may become 0.10 - 0.3% of range further. Furthermore, 0.001 - 0.20% of Ti, B0.0001-0.04% one side, or both are included. Carry out semi-continuous casting of the aluminium alloy molten metal which consists of the remainder aluminum and an unescapable impurity, and it considers as an ingot. Next, the method of heat-treating the aluminum-Cu system aluminium alloy ingot for processing characterized by cooling to the temperature of 200 degrees C or less with the cooling rate of 200 degrees C/hour or more after holding this ingot after a heating temperature up at 430-500 degrees C with the programming rate of 100 degrees C/hour or less in this temperature requirement for 1 to 24 hours.
[Claim 3] The manufacturing method of the aluminum-Cu system aluminium alloy extruded material which faces carrying out extrusion to a with an extrusion ratios of ten or more extruded material using the aluminum-Cu system aluminium alloy ingot for processing which performed heat treatment by claim 1 or two publications, carries out the preheating of this ingot to the temperature of 300-450 degrees C, and is characterized by performing extrusion as the temperature of an extruded material moreover becomes 500 degrees C or less with 1-10m extrusion rate for /.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[Industrial Application]
This invention relates to the manufacturing method of the extruded material using the method of heat-treating the aluminum-Cu system aluminium alloy ingot of an age-hardening mold which can fully maintain a strong processing organization (processing fiber texture), and this ingot, when solution treatment of the alloy after expansion processing is carried out.
[Description of the Prior Art]
By heat-treating, since the aluminium alloy of the age-hardening mold like an aluminum-Cu system alloy can give the reinforcement excellent in work timber, it is used for components on the strength, such as an automobile and a motorcycle.
That is, in order to obtain such components on the strength from an aluminum-Cu system alloy ingot, after giving the homogenization which performs maintenance of several hours near 500 degree C for an alloy ingot, in order to perform expansion processing of extrusion, rolling, forging, etc., to fabricate in a proper configuration and to give reinforcement further to the obtained processing product, a series of high temperature aging by solution treatment, hardening, and annealing is performed.
[Problem(s) to be Solved by the Invention]
However, even if the processing product obtained by the above-mentioned approach performs aging treatment, the present condition is reinforcement's sufficient like it expects beforehand in many cases not being obtained, but receiving a limit in the use as components on the strength.
This invention aims at offering the manufacturing method of an extruded material product with the high reinforcement which used the ingot obtained by the manufacturing method of an aluminum-Cu system aluminium alloy ingot and this which can obtain the processing product which has higher reinforcement after solution treatment in view of the above-mentioned actual condition.
[The means for solving a technical problem]
For artificers, the following thing is ******** as a result of studying many things about the cause that the improvement effectiveness in on the strength to the extent that the aluminium alloy of the above-mentioned age-hardening mold expected after aging treatment is not acquired. That is, if plastic working, such as extrusion and rolling, is performed to an aluminium alloy, crystal grain will deform into the flow direction of the metal by processing, and a fibrous organization will be obtained. This processing fiber texture is also called the strong processing organization, and gives high reinforcement to an alloy. by the way, when heat-treating after processing in an aluminum-Cu system alloy for an age-hardening, it will be alike occasionally and will carry out, and a strong processing organization will cause recrystallization, and it will disappear partially. Therefore, after performing a series of heat treatments for aging effect processing, it is necessary to adopt a means with which a great portion of strong processing organization is maintained. The result of having repeated examination about the approach that disappearance of the strong processing organization by heat treatment after processing can be avoided as much as possible in an aluminum-Cu system alloy based on the knowledge of the above [artificers], In the aluminum-Cu system alloy which has a specific presentation When controlling the heating rate below to a fixed value in the homogenization given to the ingot after semi-continuous casting and making it make predetermined heat treatment temperature reach The work timber obtained by adding expansion processing to the ingot obtained by giving this homogenization Even if it heat-treated solution treatment for grant on the strength etc. after that, a header and the following three invention were completed for the ability of the most to be maintained so that the above-mentioned strong processing organization may recrystallize partially and may not disappear.

The 1st invention in this invention on weight criteria 1.5 - 6.0% of namely, Cu(s), 0.10 - 1.5% of Mn, 0.2 - 2.0% of Mg, 0.1 - 1.5% of Si, and 0.1 - 0.5% of Fe(s) are contained. 0.04 - 0.10% of Cr(s) and Zr contain 0.06 - 0.20% so that Cr+Zr may furthermore become 0.10 - 0.3% of range. Furthermore, 0.001 - 0.20% of Ti, B0.0001-0.04% one side, or both are included. After carrying out semi-continuous casting of the aluminium alloy molten metal which consists of the remainder aluminum and an unescapable impurity, considering as an ingot and then carrying out the heating temperature up of this ingot to 300-430 degrees C with the programming rate of 200 degrees C/hour or less, it holds in this temperature requirement for 0.5 to 2 hours. After carrying out a heating temperature up to a 450-500-degree C temperature requirement immediately after maintenance and holding in this temperature requirement for 1 to 24 hours It is a method of heat-treating the aluminum-Cu system aluminium alloy ingot for processing characterized by cooling to the temperature of 200 degrees C or less with the cooling rate of 200 degrees C/hour or more. Moreover, invention of the 2nd of this invention On weight criteria, 1.5 - 6.0% of Cu(s), 0.10 - 1.5% of Mn, 0.2 - 2.0% of Mg, Contain 0.1 - 1.5% of Si, and 0.1 - 0.5% of Fe(s), and 0.04 - 0.10% of Cr(s) and 0.06 - 0.20% of Zr are contained so that Cr+Zr may become 0.10 - 0.3% of range further. Furthermore, 0.001 - 0.20% of Ti, B0.0001-0.04% one side, or both are included. Carry out semi-continuous casting of the aluminium alloy molten metal which consists of the remainder aluminum and an unescapable impurity, and it considers as an ingot. This ingot at 430-500 degrees C with the programming rate of 100 degrees C/hour or less Next, after a heating temperature up, After holding in this temperature requirement for 1 to 24 hours, it is a method of heat-treating the aluminum-Cu system aluminium alloy ingot for processing characterized by cooling to the temperature of 200 degrees C or less with the cooling rate of 200 degrees C/hour or more. Furthermore, the 3rd invention uses the aluminum-Cu system aluminium alloy ingot for processing obtained by the 1st invention of the above, or the 2nd invention. It is the manufacturing method of the aluminum-Cu system aluminium alloy extruded material which faces carrying out extrusion to a with an extrusion ratios of ten or more extruded material, carries out the preheating of this ingot to the temperature of 300-450 degrees C, and is characterized by performing extrusion as the temperature of an extruded material moreover becomes 500 degrees C or less with 1-10m extrusion rate for /.

[Function]

The component and content rate of an aluminum-Cu system aluminium alloy which are first used in this invention are explained.

Cu: Make easy to produce defects, such as a detailed crack conversely for [1.5-6.0%Cu coexists with Mg and raises the heat treatment reinforcement of an aluminum-Cu system alloy, if there is little improvement effectiveness in on the strength by aging treatment and it exceeds a upper limit, the effectiveness of the improvement in on the strength by heat treatment will be saturated under with a lower limit, and] plastic working.

Mg: Mg coexists with Cu 0.2 to 2.0%, the heat treatment reinforcement of an aluminum-Cu system alloy is raised, and under by the lower limit, if there is little improvement effectiveness in on the strength by aging treatment and it exceeds a upper limit, workability will come to fall.

Fe: 0.1-0.5%Fe has the effectiveness of making cast structure detailed and preventing a casting crack. When there is little the effectiveness and it exceeded the upper limit under by the lower limit, the amount of crystallization of an aluminum-Fe(X)-Si system compound (X: transition metals) or an aluminum-Cu-Fe system compound increases and plastic working is performed, while becoming easy to produce a detailed crack defect in the obtained work timber, the addition effectiveness of other effective elements added in the alloy is decreased.

Si: 0.1 - 1.5%Si has the effectiveness of depositing Mg2Si on the occasion of aging treatment, and raising the reinforcement of an alloy, by coexisting with Mg. Under by the lower limit, if there is little the effectiveness and it exceeds a upper limit, the amount of crystallization of an aluminum-Fe(X)-Si system compound (X: transition metals) will increase, and while making a detailed crack defect easy to produce in the work timber obtained by expansion processing, the addition effectiveness of other effective elements added in the alloy is decreased.

Mn: 0.10 - 1.5%Mn has the effectiveness of improving a detailed organization, nothing, and material strength in the processing organization in the work timber obtained by performing expansion processing while it makes cast structure detailed and prevents a casting crack. Under by the lower limit, if there is little the effectiveness and it exceeds a upper limit, workability will be checked.

Cr:0.04-0.10% and Zr: -- Cr and Zr by making both live together in an alloy 0.06 to 0.20% Cr and Zr which dissolved in the ingot by giving the ingot heat-treating method by this invention explained below A detailed aluminum-Cr system compound, It is made to deposit as an aluminum-Zr system compound or an aluminum-Cr-Zr system compound, the fibrous processing organization formed of processing is disturbed for advance of recrystallization in aging treatment since then, and it has the effectiveness of raising reinforcement.

A deer is carried out, and at less than 0.10%; the total quantity of Cr and Zr will reduce workability, if there is little the effectiveness and it exceeds 0.3%. Therefore, it is necessary to stop Cr and Zr content to above-mentioned within the limits.
And/or, Ti and B are independent B:0.0001 to 0.02%, respectively. Ti:0.001-0.10% -- Or live together, make cast structure of an alloy detailed, and it has the effectiveness which prevents a casting crack. Under by the lower limit, if there is little the effectiveness and it exceeds a upper limit, the huge compound of an aluminum-Ti system compound, an aluminum-B system compound, or an aluminum-Ti-B system compound will be crystallized, and it is divided on the occasion of processing, and the origin of generating comes, or it becomes the propagation path of a crack, and all fall workability, respectively.
The aluminum-Cu system aluminium alloy ingot which has the above-mentioned presentation is obtained by casting the addressing **** alloy molten metal to the specified quantity for each alloy element ingoted with the conventional method by the water cooling type semi-continuous casting method.
It is that it is desirable to perform filtration processing of the inclusion according to use of a porosity filter in to perform degasifying processing of the molten metal by the conventional method if needed on the occasion of casting **** when aiming at improvement in ingot quality.
Since the alloy element is fully dissolving, the ingot cast in the water cooling type semi-continuous casting method can fully demonstrate the addition effectiveness which was described above by heat treatment since then, respectively. Especially the size of an ingot is not limited, and when using [for example,] as an object for extrusion, smallness can adopt size as arbitration from the minor diameter billet of 20-60mmphi extent according to an application to the so-called large-sized billet more than 340phimm.
When aging treatment is performed to the alloy after expansion processing, the advance of recrystallization to the strong processing organization formed in work timber is stopped, and it enables it to maintain a strong processing organization as much as possible in the whole of the 1st and 2nd invention of this invention by homogenizing this according to specific heat treatment conditions using the aluminum-Cu system aluminium alloy ingot which has the specific alloy presentation by the semi-continuous casting manufactured as mentioned above.
Namely, in the 1st invention, face homogenizing the above-mentioned ingot, and the heating temperature up of the ingot is carried out to a 300-430-degree C temperature requirement with the programming rate of 200 degrees C/hour or less. Hold in this temperature requirement for 0.5 to 2 hours, and a heating temperature up is immediately carried out to a 450-500-degree C temperature requirement after maintenance. By performing maintenance of further 1 - 24 hours in this temperature requirement, cooling to the temperature of 200 degrees C or less with the cooling rate of 200 degrees C/hour or more after an appropriate time, and homogenizing an ingot under such heat treatment conditions.
When aging treatment is performed to the product after processing, the expansion material product of high reinforcement more remarkable than before is obtained. Although the reason is not fully clear, if the heating temperature up of the ingot is slowly carried out to the temperature near 300 degree C with the comparatively late programming rate of 200 degrees C or less, Mn, Cr, and Zr which are dissolving in an ingot in the meantime will deposit in detailed homogeneity, and will form a crystalline nucleus. Subsequently, the compound containing detailed homogeneous Mn, Cr, and/or Zr of amount sufficient during an ingot organization is made to form by once holding an ingot to a 300-430-degree C temperature requirement, and depositing Mn, residual Cr, and residual Zr.
By thus, existence of the detailed compound of transition metals, such as Mn, Cr, Zr, etc. in which homogeneity carries out deposit formation into an ingot In an ingot, when aging treatment is performed after expansion processing, disappearance by the recrystallization of a fibrous strong processing organization currently formed in expansion material is barred. Since the great portion of strong processing organization remains, in addition to the improvement effectiveness in on the strength of aging nature alloy original based on aging treatment, an alloy is considered that it can obtain still higher reinforcement.
In order to fully demonstrate the effectiveness of this invention, when it is indispensable to carry out the heating temperature up of the programming rate of an ingot with the comparatively low programming rate of 200 degrees C or less and it is a larger programming rate than this, the compound by Cr, Zr, etc. which deposit in an ingot can become big and rough, homogeneity cannot be deposited, and expected effectiveness is not acquired. Moreover, when low-temperature maintenance of 300-430-degree C 0.5 - 2 hours is also important requirements and this maintenance condition is the temperature of less than 300 degrees C, or the holding time of less than 0.5 hours, the detailed sludge of homogeneous and sufficient amount is not formed into an ingot, and expected effectiveness is not acquired. Moreover, even if it holds temperature exceeding 430 degrees C, or time amount exceeding 2 hours, the above-mentioned effectiveness cannot be made to increase more than by this, but it becomes disadvantageous rather economically.

Although the temperature up of the ingot is carried out to 450-500 degrees C after that and maintenance of 1 - 24 hours is performed By the aging treatment which this makes elements, such as Cu, Mg, Fe, Si, etc. which were segregated in casting, re-dissolve, and follows expansion processing since then and this It is for demonstrating the reinforcement of age-hardening mold alloy original. Maintenance conditions The temperature of less than 450 degrees C, Or when it is less than 1 hour, there is little the effectiveness, and it is also held by the temperature exceeding 500 degrees C, or the time amount exceeding 24 hours, the above effectiveness is not acquired, and it is not economical.
Next, the ingot which ended the maintenance in an elevated temperature is cooled until ingot temperature turns into temperature of 200 degrees C or less with the cooling rate of 200 degrees C/hour or more immediately. By holding in temperature of 450-500 degrees C previously, a re-deposit of Cu and Mg which were made to dissolve can be prevented as much as possible, and this deposits sufficient amount of these elements by the aging treatment of expansion material since then, it is for raising reinforcement, for example, can obtain this cooling rate with means, such as forced-air cooling.
It carries out by the temperature gradient 100 degrees C [/hour] or less of a still lower programming rate rather than it can set heating in homogenization of an ingot to the 1st invention in the 2nd invention. Moreover, after reaching 430-500 degrees C, By holding to this temperature for 1 to 24 hours, cooling to the temperature of 200 degrees C or less with the cooling rate of 200 degrees C/hour or more after an appropriate time, and heat-treating an ingot on such heat treatment conditions The reinforcement after the aging treatment of the expansion material product obtained by performing expansion processing like the 1st invention can be raised compared with the former. As the reason, if the programming rate of an ingot is slowly heated to a 430 degrees C - 500 degrees C temperature requirement with the programming rate of 100 degrees C/hour or less still later than the case of the 1st invention Deposit still more homogeneously [Mn, Cr, and Zr in an ingot] minutely in the meantime, form a crystalline nucleus, and by maintenance in further 430-500 degrees C The detailed compound of sufficient amount of these Mn, Cr, and Zr is formed in homogeneity, and this is considered to do the effectiveness which was excellent in the increment on the strength after the aging treatment in the expansion material product after expansion processing of an ingot for the same reason with having described the 1st invention.
Since an alloy ingot is heated in **** 2 invention with the programming rate 100 degrees C [/hour] or less of a programming rate still lower than the 1st invention, Mn, Cr, and Zr which are dissolving in the ingot in the process of a temperature up deposit homogeneously [and] minutely. Therefore, even if it does not perform heating maintenance at low temperature which was performed in the 1st invention, the detailed compound based on the deposit of Mn, Cr, and Zr of sufficient amount can be secured. a sludge with Mn, Cr, and Zr larger when in other words a programming rate exceeds an hour in 100 degrees C /which deposit in an ingot -- becoming -- therefore, the generating point of a crystalline nucleus -- more -- rough -- ** -- it must stop having to expect generating of further many sludges by ** by [as / in the 1st invention] performing maintenance at low temperature further
A part of maintenance in a 430-500-degree C temperature requirement does not change with the case of the 1st invention and have that it is for aiming at re-dissolution of elements, such as Cu, Mg, Fe, Si, etc. which are essentially segregated in an ingot, and aiming at improvement in on the strength by the aging treatment of the work timber product obtained by expansion processing, although formation of the further deposit compound of Mn, Cr, and Zr is also expected. Therefore, it is the same as that of the 1st invention also about maintenance conditions becoming disadvantageous economically in the maintenance of time amount which exceeds that there is little the effectiveness and the temperature to which it exceeds 500 degrees C, or 24 hours at the temperature of less than 430 degrees C, or the holding time of less than 1 hour.
Moreover, it is as having also explained the reason made to quench the ingot which ended heating maintenance to the temperature of 200 degrees C or less at the temperature of 200 degrees C/hour or more by the term of the 1st invention.
Although the aluminum-Cu system alloy ingot which homogenized can obtain the processing product which has the configuration of arbitration by performing expansion processing of extrusion, rolling, forging, etc. according to the heat treatment conditions shown in the 1st or 2nd above-mentioned invention, remarkable effectiveness is shown when based especially on extrusion.
After the 3rd invention offers the desirable extrusion method for obtaining the extruded material product which has the reinforcement which was excellent from this aluminum-Cu alloy ingot and carries out the preheating of this ingot to a 300-450-degree C temperature requirement, as an extrusion ratio is made or more into ten and the temperature of an extruded material moreover does not exceed 500 degrees C with 1-10m extrusion rate for /, it performs extrusion.
Heating an ingot beforehand to a 300-450-degree C temperature requirement is performed in order to raise the extrusion nature of an ingot, and if there is little the effectiveness and it exceeds 450 degrees C, the temperature of an

extruded material will go up by preheat temperature of less than 300 degrees C too much with the generating heat for processing, and it has with it the danger that the fiber texture by processing will disappear with recrystallization.
The extrusion ratio was made or more into ten for fully developing processing fiber texture into an extruded material. If a part for 10m/is exceeded, the processing organization of an extruded material will recrystallize with the generating heat by processing, high intensity will not be obtained too, and the extrusion rate was limited to 1-10m range for /because it was lacking in economical efficiency in the following by 1m/.
It is because an extruded material will carry out surface degradation and will become easy to produce a crack, if controlling so that the temperature of an extruded material does not exceed 500 degrees C exceeds 500 degrees C. Moreover, the temperature up of the ingot in a dice is carried out with the generating heat by processing, the temperature of the extruded material obtained in an anaphase rather than the early stages of extrusion rises, and it becomes easy to cause recrystallization as extrusion actuation generally progresses in extrusion. Therefore, when the temperature within an extruder exceeds 500 degrees C during processing, it is necessary to adopt cooling means, such as carrying out forced-air cooling of the extruded material in a dice edge.
Thus, the obtained extruded material performs aging treatment next, and gives high intensity. It holds to a 495-510-degree C temperature requirement for 0.5 hours or more, and solution treatment is performed, subsequently to a 160-180-degree C temperature requirement, it holds after tempering this for 2 to 8 hours, and temper processing is performed so that it may generally be carried out as conditions for aging treatment.
The extruded material obtained by adopting the extrusion conditions especially indicated in the 3rd above-mentioned invention in the aluminum-Cu system alloy ingot which gave the homogenization by the 1st invention or the 2nd invention, and performing extrusion can be used as the extrusion product which was excellent in the reinforcement which is not in the former by performing aging treatment.
[Example]
Next, in order to prove the operation effectiveness of this invention, some examples which the artificer performed are explained.
The ingot for extrusion of 325mmphi was obtained from 15 kinds (this invention alloy: alloy numbers 1-10 and comparison alloy:alloy number 11-15:) of aluminum-Cu system aluminium alloy molten metals which have chemical composition as shown in the 1st table using the water cooling type continuous casting process.
Next, the thing which homogenized the alloy (alloy numbers 1-10) and comparison alloy (alloy numbers 11-15) which correspond to the presentation range of this invention in an example 1 as these ingots are used and it is shown in the 2nd table on two steps of heat treatment conditions of the 1st invention of this invention, In the example 2, the homogenization by one-step heat treatment, the heat treatment conditions, i.e., the low programming-rate conditions, of the 2nd invention of this invention, is given, respectively about this invention alloy (alloy numbers 2 and 10) and a comparison alloy (alloy numbers 11 and 14),

第 1 表

	合金番号	化学組成(wt%)										
		Cu	Mg	Fe	Si	Mn	Cr	Zr	Ti	B	その他	Al
本発明合金	1	1.8	1.5	0.2	0.1	0.65	0.06	0.08	0.01	—	0.01	残
	2	3.5	1.5	0.2	0.1	0.65	0.05	0.07	0.01	—	0.01	残
	3	3.5	1.0	0.2	0.1	0.65	0.05	0.10	0.02	—	0.01	残
	4	4.5	0.3	0.4	0.1	0.65	0.08	0.06	0.01	—	0.01	残
	5	4.5	1.5	0.1	1.2	0.20	0.06	0.08	0.01	—	0.01	残
	6	5.8	0.5	0.1	0.5	0.80	0.04	0.20	0.01	—	0.01	残
	7	4.5	1.5	0.1	0.1	1.30	0.10	0.18	0.01	—	0.01	残
	8	2.5	1.5	0.1	0.1	0.65	0.06	0.07	0.01	0.001	0.01	残
	9	4.5	1.0	0.2	0.8	0.65	0.06	0.08	0.01	—	0.01	残
	10	4.5	1.5	0.2	0.3	0.65	0.04	0.06	0.01	0.001	0.01	残
比較合金	11	4.5	1.5	0.2	0.2	0.65	—	—	0.01	—	0.01	残
	12	4.5	1.5	0.2	0.2	0.65	0.06	—	0.01	—	0.01	残
	13	4.5	1.5	0.2	0.2	0.65	—	0.06	0.01	—	0.01	残
	14	4.5	1.5	0.2	0.2	0.65	0.12	—	0.01	—	0.01	残
	15	4.5	1.5	0.2	0.2	0.65	—	0.25	0.01	—	0.01	残

注：第1表中その他は表示以外の元素の夫々を示し、その含有量の0.01は夫々0.01以下であることを示す。

第2表

実施例No.	合金番号	均質化処理条件			
		昇温	保持	保持	冷却
①	1 ～15	100℃/h→	350℃×1h→	460℃×4h→	300℃/h
②	2、10、11、14	50℃/h	→	460℃×4h→	300℃/h
③	2、10、11、14	250℃/h	→	460℃×4h→	100℃/h

In the thing and example 3 which carried out forced-air cooling of this after cutting, about two sorts of alloys same as the above The homogenization by one-step heat treatment which heats with a programming rate quite higher than the conventional general heat treatment conditions, i.e., the programming-rate conditions of the 2nd invention of this invention, is given. About what was cooled radiationally after processing, as the temperature in the dice edge of an extruded material became 500 degrees C or less by part for extrusion rate/of 4m after the preheating about each ingot at the extrusion conditions of this invention, i.e., 400 degrees C, extrusion of the round bar with a path 50mmphi and a die length of 50m was performed. Next, after holding to the obtained round bar for 2 hours at 500 degrees C, water quenching was performed, solution treatment was performed, subsequently to 170 degrees C it held for 6 hours, and artificial-aging processing (T6 processing) was performed.

A strength test sample and a histological tissue examination sample are started from the location of about 20m from the tip of the extruded material which performed these T6 processing, and about 40m, and it is a deed about measurement of tensile strength (sigmaB) and proof stress (sigma0.2) about a strength test sample. Moreover, about the histological tissue examination sample, it gazed at the alloy organization by the optical microscope, the recrystallization thickness to the diameter direction was measured, and the ratio was computed.

第３表（実施例1）

	合金番号	20m σB	20m σ0.2	40m σB	40m σ0.2	20m 再結晶厚%	40m 同%	評価 強度	評価 組織
本発明合金	1	35	32	35	31	0.05	0.05	○	○
	2	54	50	53	51	0.03	0.05	○	○
	3	53	51	52	50	0.03	0.06	○	○
	4	52	48	51	49	0.06	0.08	○	○
	5	62	58	59	56	0.05	0.10	○	○
	6	50	46	50	46	0.07	0.07	○	○
	7	60	55	59	56	0.05	0.05	○	○
	8	40	35	41	34	0.06	0.06	○	○
	9	58	56	57	54	0.06	0.08	○	○
	10	61	57	59	56	0.07	0.10	○	○
比較合金	11	53	51	48	45	1.0	5.0	×	×
	12	54	52	49	45	1.1	1.5	△	×
	13	52	49	48	45	1.2	2.1	×	×
	14	55	50	49	46	1.0	1.1	△	×
	15	55	50	50	45	1.0	1.2	△	×

注：表中20m、40m はビレット先端部からの試料採取位置を示す。
またσB、σ0.2 の単位は kg/mm² である。

第４表

合金番号	(実施例2) σB kg/mm² 20m	(実施例2) σB kg/mm² 40m	(実施例2) 再結晶厚% 40m	(実施例3) σB kg/mm² 20m	(実施例3) σB kg/mm² 40m	(実施例3) 再結晶厚% 40m
2	52	51	0.06	49	47	1.0
10	58	57	0.12	55	50	1.2
11	51	46	7.0	50	44	12.0
14	55	50	1.2	52	48	1.5

注：表中20m、40m はビレット先端部からの試料採取位置を示す。

The result which calls the result depended on the ingot of an example 1 at the 3rd table again at the ingot of examples 2 and 3 is shown in the 4th table, respectively.
Namely, the reinforcement after the aging treatment in two different places before and after the extruded material which performed extrusion according the ingot whose 3rd table homogenized according to the heat treatment conditions by the 1st invention of this invention about this invention alloy and the comparison alloy to the 3rd invention of this invention, Although the result of having investigated the condition of recrystallization is shown The extruded material obtained from the ingot which homogenized according to the heat treatment conditions according the aluminum-Cu alloy ingot (alloy numbers 1-10) which has the alloy presentation by this invention which made the optimum dose of Cr and Zr live together from the result of the 3rd table to the 1st invention has the thin thickness of the recrystallized layer after aging treatment. All the percentages of the thickness of the recrystallized layer occupied in the diameter direction of an extruded material are 0.1% or less, and recrystallization does not very advance. And it

receives that particular change cannot be found very much in the value in which part before and after a product (20mm from a tip, and 40mm). In the extruded material product obtained from the comparison alloy ingot (alloy numbers 11-15) of a presentation which separates from the presentation of this invention which adds Cr and Zr independently, respectively or is not added at all, the thickness of a recrystallized layer is thick, the ratio to a diameter is one or more, and recrystallization is progressing the considerable grade. And if the variation in the value measures the reinforcement of the product obtained from the large thing and this invention alloy in this table (alloy numbers 5, 7, and 10), and the product obtained from the comparison alloy (alloy numbers 11-15) by the anterior part and the posterior part of a product From the place where these products have same Cu and amount of Mg which are contained in an alloy, what is depended on this invention alloy in spite of expecting that the reinforcement after aging treatment will be in the same level mostly what is depended on a comparison alloy -- comparing -- tensile strength and proof stress -- the value is remarkably high even if it takes any -- a seal or **. Moreover, for all the things that used the alloy which has the presentation which corresponds to presentation within the limits of this invention from the result of the 3rd table, it is a seal or ** for a recrystallized layer to be thin, that is, for a strong processing organization to remain notably after aging treatment, therefore to bring a desirable result at the improvement in on the strength of an extruded material.
The 4th table left column (example 2) the ingot which homogenized on the heat treatment conditions which carry out a temperature up with the late programming rate by the 2nd invention about this invention alloy (alloy numbers 2 and 10) and a comparison alloy (alloy numbers 11 and 14) The right column (example 3) moreover, the ingot which homogenized with the programming rate earlier than the usual programming rate, i.e., the programming rate by the 2nd invention, about the same alloy Although the result of having investigated the advance situation of the recrystallization in the reinforcement in two places (they are 5m and 40m from a tip) and a posterior part (it is 40m from a tip) before and after the extruded material after aging treatment about the extruded material which performed extrusion according to the extrusion conditions of this invention, respectively is shown [when heat treatment by the 2nd invention is performed from the result of the 4th table left column example 2] The thickness of the recrystallized layer after the aging treatment of the extruded material obtained when the alloy (alloy numbers 2 and 10) of this invention was used is thin. Recrystallization progresses not much, to ****, in comparison alloy (alloy numbers 11 and 14) use, the thickness of a recrystallized layer is thick and recrystallization is advancing considerably, Moreover, it is a seal or ** that the thickness of the recrystallized layer in an extruded material is thick, that is, recrystallization advances when this invention alloy is used from the result of the 4th table right column example 3 and homogenization is also ******** about the conditions of the 2nd invention etc.
Moreover, when the result which shows the advance situation of this recrystallization affects the reinforcement of an extruded material immediately and the alloy of same Cu and Mg content is compared among this invention alloy in the 4th table left column, and a comparison alloy, it sets. Although are based on this invention alloy of the alloy number 10 and reinforcement is based on the comparison alloy of the alloy numbers 11 and 14, compared with reinforcement, a remarkably high thing ** in a seal. Moreover, the programming rate for [even when the alloy which has the same presentation of this invention is used from the on-the-strength measurement result shown in the right-and-left column] homogenization is larger than the degree ** of temperature up of **** 2 invention. It is a seal or ** that reinforcement falls remarkably while the thickness of the recrystallization in an extruded material becomes thick, when based on the conventional usual heat treatment conditions that the cooling rate after homogenization is slow.
As the expansion processing method for performing the above example after homogenization of an ingot, although what adopted the extrusion especially by the 3rd invention of this invention was described, a processing means is not restricted to this, and when, adopting other processing methods, such as the method of processing it other than this, for example, strip processing, and forging, of course, it can expect the similarly excellent effectiveness.
[Effect of the Invention]
Since the disappearance of processing fiber texture accompanying advance of the recrystallization after the aging treatment of aluminum-Cu system aluminium alloy expansion material is suppressed when adopting the homogenization approach of the ingot of this invention, as stated above, and the reinforcement of a work timber product can be conjointly raised further further with the aging treatment effectiveness, it can be said that it is high invention of industrial utility value.

[Translation done.]